ASSESSMENT OF REGIONAL DIGITAL DIVIDE IN TÜRKIYE

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Abstract: Technological advancement has not been equally distributed. It has differed from country to country, region to region, and even among individuals. As a result, the digital divide has emerged as an umbrella term to represent these disparities. Recently, the research focus has shifted to the outcomes of information and communication technology usage or tangible benefits (the third-level digital divide). As an emerging economy, Türkiye must overcome the digital divide to maximise tangible benefits. Thus, this research starts by determining the digital divide indicators for Türkiye and goes further to examine the digital divide between regions in Türkiye. The main aim is to present a comprehensive index for the regional scale that is currently missing in the literature. To do so, this research starts with exploring the digital divide indicators. Then, with the help of principal component analysis (PCA), a new index is formulated for Türkiye. The result maps indicate digital inequalities both at regional and city scales, yet inequalities are more remarkable at the city scale. Increasing the diversity of technology usage, focusing on gender equality, expanding R&D expenditures, and supporting initiatives, especially ICT initiatives, will assist Türkiye in reducing digital inequalities.

Keywords: ICTs, digital divide, regional disparities, Türkiye

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Introduction

The world is changing rapidly, especially in the last decade. This change has accelerated with the help of new technological developments. Graham (2002) emphasised the two leading forces shaping the current era: urbanisation and digital information and communication technologies (ICTs). As of January 2021, 59.5% of the global population (4.66 billion active Internet users) are online (Statista 2022). Likewise, the urban population reached 55% of the world's population (4.2 billion inhabitants) in 2020. By 2050, it is estimated that approximately seven out of 10 individuals will live in cities (The World Bank 2020). Given the information, these two topics have become crucial for sustainable development policies. Not surprisingly, the United Nations (2015) pointed out their significance in the *Sustainable Development Goals* via many targets.

Despite these rapid developments, inequalities still exist. In 2019, a global breakpoint showed how vulnerable our world and cities are. ICTs have become even more critical of the influence of the lockdown period due to the unexpected COVID-19 pandemic. Improved digital infrastructure and society with digital abilities increased the potential to cope with several emergencies from COVID-19. Quite the reverse, the challenges worsened in countries with fewer digital opportunities. According to the OECD report (2021), the percentage of teleworking

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doubled from 16% in 2019 to 37% of employees in April 2020. However, Türkiye only had 3% of employees working at home during lockdowns in 2020. Another critical impact was observed in education. *The State of the Global Education Crisis: A Path to Recovery Report* stated that full and partial school closures lasted about 224 days worldwide (The World Bank, UNESCO, UNICEF 2021). According to Ministry of Education statistics[1], more than seven million students actively used online education platforms during the lockdown period in Türkiye. According to the 2018 Programme for International Student Assessment (PISA) data, in Türkiye, 67% of students reported having a computer they could use for school work, which is lower than the OECD average (89%). Urbanisation can also be a determinant. The *OECD Regions and Cities at a Glance Report* (2020) states that "in 26 OECD countries, 1 in 3 households in rural areas do not have access to high-speed broadband on average" (OECD 2020a,b: 52). The COVID-19 pandemic proves that the digital divide still exists in different scopes of everyday life.

In the light of all information mentioned above, it is evident that digital inequalities can affect our lives; consequently, it becomes a vital theme for countries to monitor digital progress to have inclusive policies. Thus, this research will focus mainly on the literature on digital divide. Various studies are being conducted to discover the reasons behind digital inequalities. Primarily, researchers concentrated on having an Internet connection or not (the first-level digital divide); after that, the research focus shifted to ICT skills and usage (the second-level digital divide); lately, the research focus has turned to the outcomes of ICT use or tangible benefits (the third-level digital divide). Because of the complex nature of the digital divide, indexes deal with various aspects. The most recent indexes are the ICT Development Index (IDI) (ITU 2017), Digital Economy and Society Index (DESI) (EU 2018), and Going Digital Toolkit (OECD 2021a,b,c). Despite the fact that all the existing monitoring tools are examining digital inequalities on an international level, digital divide could differ between regions within the same country (Vicente, Lopez 2011). Besides, new research indicates that regional instruments support national measures to mitigate the digital divide (Szeles 2018). There are a few studies to reveal regional disparities in Türkiye in terms of the digital divide (Guz 2019; Koramaz et al. 2019; Ozcan Alp, Baycan 2024). Yet, no tool has been developed to monitor digital disparities between Türkiye's regions. As an emerging economy, Türkiye needs to overcome the digital divide to maximise tangible benefits and boost innovation. This study aims to formulate a new index for monitoring regional digital divide in Türkiye. To do so, research starts with an inevitable question: What are the digital divide indicators in the case of Türkiye? Then goes further to reveal the digital divide between regions in Türkiye by using these indicators. Thus, the research involves three steps: finding digital divide indicators, formulating an index, and applying it for Türkiye.

The research is structured in five sections. The following section focuses on the literature on digital divide and the evolution of the term since the beginning. The second section also includes investigating recent indexes to understand digital divide indicators for all levels. The third section explores the indicators related to digital disparities in Türkiye and develops a new regional monitoring index. This allows us in the fourth section to use the new tool for revealing regional disparities in Türkiye. The final part provides brief conclusions and future research topics.

Brief evolution of the digital divide

The digital divide has emerged as an umbrella term for various aspects of digital disparities between individuals. The term entered common usage by the beginning of the 20th century and has been studied by several scholars. The digital divide was initially used in an official report *Falling Through the Net* by the US Department of Commerce's National Telecommunications and Information Administration (NTIA 1995), in which the term is not used as 'digital divide' but instead referred to those who have access to the Internet and who have not (the first-level digital divide). Conversely, the 1999 report *Falling*

[1] https://www.meb.gov.tr/turkiye-uzaktan-egitim-istatistikleriyle-dijital-dunyanin-listelerini-zorladi/haber/21158/tr Source: Ministry of National Education (MEB), 2020.

Through the Net did refer to the digital divide by counting all new technologies (NTIA 1999). After much research on material access, the term adjusted and comprehended additional aspects. According to Scopus, there were over 1,000 publications on this phenomenon since 2005 (Scopus 2022). In Table 1, three different phases of the digital divide are shown.

Initially, the term referred to material access (having Internet or not) (NTIA 1999), transformed into a more social issue, and included not only material access but also skills to use the Internet or computer (DiMaggio, Hargittai 2001). As a final step, the scope is broadened by outcomes of ICT use or tangible benefits (Warschauer 2011; van Deursen, Helsper 2015).

In the 2000s, some scholars claimed that the digital divide was shrinking because of the rapid penetration of the mobile Internet (Stump et al. 2008). However, in 2019, a global pandemic has shown that the digital divide still exists; as van Dijk explained, "The digital divide cannot be closed completely. When the whole world population would reach access to the digital media such as the Internet, inequalities of digital skills, usage and outcomes or benefits remain and even tend to grow" (van Dijk 2020: 1). Thus, the digital divide is needed to be considered for comprehensive development policies.

These theoretical digital divide considerations have affected the indexes that track countries' digital progress. Because of its complex nature, the indexes have many indicators related to all three levels. Table 2 lists the most comprehensive and recent ones, which include different aspects of the digital divide.

The International Telecommunication Union (ITU) formulated the IDI to meet ITU Member States' demand to establish an overall ICT index in 2008. The IDI aggregates several indicators into a single number to capture the complexity of the digital divide. It comprises 12 indicators within three sub-indexes corresponding to technical infrastructure, usage, and skills (ITU 2017). DESI has been an annual tool for monitoring European Union (EU) member states' digital progress since 2014 (EU 2021). Its purpose is to support the member states in identifying areas for priority action each year. Table 2 shows that DESI has four main themes: technical infrastructure, ICT usage among individuals and enterprises, e-government, and e-commerce. The scope of

Table 1. Three levels of digital divide (adopted from van Deursen, van Dijk 2018).

Source	Date	Main theme	Level	Definition
NTIA	1999	Internet connection	First-level digital divide	"The divide between those with access to new technologies and those without*"
DiMaggio & Hargittai	2001	Internet skills and usage	Second-level digital divide	"…variation in the technical means (hardware and connections) by which people access the Web…. exercise autonomy in their use of the Web. ….in the skill that people bring to their use of the Internet. ….in the social support… …in the purposes for which people use the technology." (p. 8)
Warschauer	2011	Outcomes and tangible benefits	Third-level digital divide	"the digital divide refers to social stratification due to unequal ability to access, adapt, and create knowledge via use of information and communication technologies (ICT)." (p. 5)

* https://www.ntia.doc.gov/legacy/ntiahome/fttn99/introduction.html.
Source: National Telecommunications and Information Administration (NTIA) 1999, U.S. Department of Commerce.

Table 2. Three current international indexes with their sources and key themes.

Name	Source	Key dimensions	Number of indicators
IDI	ITU 2017)	ICT access; ICT use; ICT skills	12
DESI	(EU 2021)	Human capital; Connectivity; Integration of digital technology; Digital public services	33
Going Digital Toolkit	(OECD 2021a,b,c)	Access; Use; Innovation; Jobs; Society; Trust; Market openness	43

Source: authors.
DESI – Digital Economy and Society Index; ICT – information and communication technology; IDI – ICT Development Index; ITU – International Telecommunication Union.

DESI is more comprehensive than IDI and more complex as well. Not only material access but also usage, skills, and outcomes are targeted in DESI. However, it boosts the number of indicators (there are 33 indicators).

As the last index, OECD identifies seven policy dimensions in the Going Digital Toolkit (OECD 2021a,b,c) to shape digital transformation. The Going Digital Toolkit tackles various areas, such as embracing education, innovation, trade, and socio-economic outcomes. The index aims to assist governments with a complete governmental approach to the digital economy strategy. Unlike the previous two indexes, the Going Digital Toolkit recognises trust issues in digital technology. It uses some indexes as an indicator, such as OECD Digital Services Trade Restrictiveness Index and OECD Foreign Direct Investment Regulatory Restrictiveness Index, which are calculated on a country scale. In Appendix A, all indicators are listed in detail for each index. In the next section, indicators related to three levels of the digital divide will be discovered with the help of the indexes aforementioned and several scholars.

The first-level digital divide: Material access

The World Wide Web was invented in 1989 by the British computer scientist Tim Berners-Lee and started a revolution in the world (Bory et al. 2016). Parallel to computer and telecommunication technology evolution, in 2001, a life-changing association occurred via a smartphone connection with an existing 3G network (Jackson 2018). Since then, global Internet access has been growing each year. Statista (2021) states that the worldwide Internet penetration rate is 63%, increasing yearly. Thus, a common opinion among policy-makers is that the digital divide problem will be solved after universal access (van Deursen, van Dijk 2018). Conversely, the current situation is far from universal access. The Internet penetration rate differs in some parts of the world; for example, in developed and developing countries, the proportion of people using the Internet reaches 90% and 57%, respectively (Statista 2021). This disparity worsens in the least developed countries, where Internet access is estimated at 27% (Statista 2021). It is evident that economic development is one of the digital divide reasons. Thus, the prominent inequality occurred via the first stage: access to the Internet.

In addition to Internet access, another essential material access is ICT devices. Thanks to technological improvement, smartphones have become more widely available. In the least developed regions, there is a massive increase in people going online. However, some scholars suggest material inequality still requires attention (van Dijk 2005; Gonzales 2016). Van Deursen and van Dijk claimed that "material access includes the means required to maintain the use of the Internet over time, such as computer devices (e.g., desktops, tablets, Smart TVs), software (subscriptions), and peripheral equipment (e.g., printers, additional hard drives)" (2018: 355). The same study defines the 'mobile underclass' as people generally using smartphones and tablets for leisure purposes (gaming and social networking). They also mentioned device opportunity stating that "some combinations of devices are less likely to be beneficial than others in providing a wider variety of Internet uses and outcomes" (van Deursen, van Dijk 2018: 357).

Furthermore, new material divides appear simply because not all of the materials provide the same online opportunities; new material divisions emerge because of rapidly changing technology (van Deursen, van Dijk 2018). On the other hand, maintenance expenses are essential to sustain subscriptions and devices (Gonzales 2016). In 2018, van Deursen and van Dijk's study revealed that the first-level digital divide remained a problem in terms of "diversity in access to devices and peripherals, device-related opportunities, and the ongoing expenses required to maintain the hardware, software, and subscriptions affect existing inequalities related to Internet skills, uses, and outcomes" (p. 354). It is reasonably surprising that the Netherlands, one of the most technologically advanced countries worldwide, where 98% of the population has home Internet access, still has first-level digital inequalities (van Deursen, van Dijk 2018).

There are many indicators related to the first-level digital divide in the indexes mentioned before, such as fixed or mobile broadband subscriptions, Internet speed, computer ownership, 4G/5G coverage, and broadband price. In the Digital Tool Kit, there are specific indicators like

machine-to-machine (M2M) SIM cards per 100 inhabitants, the share of businesses with a broadband contracted speed of 30 Mbps or more, and the disparity in broadband uptake between urban and rural households. All indicators are listed in Appendix B.

The second-level digital divide: Skills and usage

According to recent statistics, there are 4.66 billion active Internet users worldwide, that is, 59.5% of the global population (Statista 2021). The percentage of active Internet users that accessed the Internet via mobile devices is 92.6 (Statista 2021). This statistic demonstrates the significance of affordable tools. However, some scholars discovered that people who only access the Internet through mobiles tend to have lower skills and conduct less diverse online activities than those who can use a computer (Correa et al. 2020). Thus, being online does not mean having equal benefits from the Internet. As Warschauer explained, "What is at stake is not access to information technology in the narrow sense (of having a computer on the promises) but in a much wider sense of being able to make use of information technology for productive ends" (2011: 2). In that case, the *second-level digital divide* becomes a hot topic on the literature on digital divide. Primarily, Kling (2000) pointed to the importance of inequality in users' possession of "know-how, a mix of professional knowledge economic resources, and technical skills, to use technologies in ways that enhance professional practices and social life" (Kling 2000: 256). After that, a study on the level of digital skills exposed the fact that "differences in digital proficiencies create new inequalities" (DiMaggio, Hargittai 2001). According to the study, "'Internet' itself is not a fixed object, but rather a protean family of technologies and services that is being rapidly reshaped through the interacting efforts of profit-seeking corporations, government agencies, and nongovernmental organizations. Patterns of inequality will reflect not just differences in individual resources, but also the way in which economic and political factors make such differences matter" (DiMaggio, Hargittai 2001: 4). The paramount need is to know how to use ICT to benefit from it. As a result, the scope of ICT usage becomes vital; social media usage, e-government usage, health data sharing intensity, cloud, and AI usage are indicators in DESI (EU 2018). Similarly, the Going Digital Toolkit offers indicators relevant to the scope of usage, such as the share of individuals using the Internet to interact with public authorities and the percentage of Internet users who have purchased online.

The second-level digital divide has many aspects, such as scope and diversity of use, types of skills, and education (DiMaggio, Hargittai 2001; Warschauer 2003; van Deursen, van Dijk 2018). Furthermore, second-level digital divide indicators deal with ICT usage among individuals and public and private sectors. Especially digitalisation of SMEs is a hot topic (OECD 2021a,b,c). The percentage of individuals using the Internet, SMEs with at least a basic level of digital intensity, SMEs selling online cross-border, the share of small businesses making e-commerce sales, the percentage of companies with a web presence, and the share of businesses purchasing cloud services are some indicators associated to SMEs digitalisation.

As a final comment for the three indexes, most indicators are intensely connected to the second-level digital divide. It is because the scope of the second-level digital divide is extensive. Here are distinctive indicators: basic digital skills, basic software skills, social media usage, big data usage, e-government users, and share of businesses purchasing cloud services. All indicators are listed in Appendix B.

The third-level digital divide: Outcomes or tangible benefits of ICT

The third-level digital divide is a relatively new topic in digital divide studies. The focus shift from skills and use of ICT to the beneficial outcomes of using ICT has been labelled the 'third-level digital divide' (Wei et al. 2011). Warschauer defined it as "social stratification due to unequal ability to access, adapt, and create knowledge via use of information and communication technologies (ICT)" (Warschauer 2011: 5). In other words, there are disparities in the ability to use online resources to have offline outcomes (van Deursen, Helsper 2015). An important question emerged: What are ICT outcomes or offline turnouts? There are various outcomes of ICT, both positive and negative.

Economic consequences include increased employment earnings, teleworking opportunities, and new job creation. Another influential outcome is educational opportunities via online education. Moreover, e-services help inhabitants to get in touch with public authorities and provide a base for public participation and social interaction. Finally, ICT can create a base for innovation, which can be counted as one of the most significant benefits of ICT. In this study, economic outcomes are accepted as the primary outcome.

DiMaggio and Bonikowski (2008) already revealed that employment earnings are triggered by more intensive Internet usage. Likewise, teleworking opportunities helped people to work from home during the pandemic. Technological circumstances transform not only companies but also individuals and make them more global. Van Deursen and Helsper suggest a dual relation: "Individuals who consistently convert their internet use into high offline returns such as earnings may benefit from a feedback effect where greater economic resources enable them to further develop their internet skills" (2015: 32). This dual relation is also valid for countries. Dewan and Kraemer (2000) discovered that ICT investment correlates with the level of development and relates to higher output in developed countries. The information economy is growing with new ICT task-intensive job opportunities. Additionally, Singer's (1970) theory of 'technological dualism' indicates the imbalanced progress in science and technology between rich and developing countries. This theory is coherent with "the outcomes of the dynamics of IT development that, so far, have resulted in 96% of total world IT research and development being located in rich countries" (Holley 2005: 200). In Türkiye's case, it is vital to use technology as a booster of innovation to maximise the ICTs' outcomes and to overcome technological dualism.

Van Deursen and Helsper show that "when information and services are offered online (or replaced by online counterparts), the number of potential outcomes the internet has to offer increases" (2015: 47). Additionally, OECD claims that "digital technologies have the potential to boost more inclusive and sustainable growth by spurring innovation, generating efficiencies and improving services" (OECD, 2020c). Not surprisingly, in the Going Digital Toolkit, there are several indicators in innovation theme, such as business R&D expenditure in information industries as a percentage of GDP, the share of start-up companies in the business population, the top 10% most-cited documents in computer science as a percentage of the top 10% ranked documents, and patents in ICT-related technologies as a percentage of total IP5 patent families (OECD 2021a,b,c). In addition, researchers emphasise how digitalisation goes beyond the classic, technical understanding and encompasses shaping social, economic, and specialised structures: "Transformations in mobile media, internet development and digital publications are striking examples of digitalization currently taking place. In these examples, digital innovations take place not only in innovations themselves but are also a result of the broader, socio-technical transformations of markets and industries" (Shakina et al. 2021: 3).

In the indexes mentioned in the second section, there are fewer indicators related to the third-level digital divide than at other levels. For example, in the IDI, no variable is associated with the third-level digital divide. DESI has four variables. Here are some variables: a share of start-up companies (up to 2 years old) in the business population, ICT task-intensive jobs as a percentage of total employment, digital public services for citizens and businesses, and open data usage. Two of them are associated with adverse outcomes of new technologies: e-waste generated kilogrammes per inhabitant and percentage of Internet users experiencing abuse of personal information or privacy violations. All indicators are listed in Appendix B.

Additional divides: Demographic and socio-economic factors

In addition to all these levels of the digital divide, it is accepted by many international institutions that there are many demographic and socio-economic factors related to digital inequalities (ITU 2017, EU 2018, OECD 2021a,b,c). According to the EU, it is stated that factors such as gender, age, education, income, social groups, and geographical location can be determinative (Eurostat 2019). Additionally, many scholars propound demographic elements such as race/ethnicity, population density, urban/rural

dimension, country size, employment status, and occupation (DiMaggio, Hargittai 2001; Billon et al. 2009; Scheerder et al. 2017; Grishchenko 2020; Lythreatis et al. 2022). DiMaggio and Hargittai (2001) claimed that enhancing human capital will strongly predict Internet use, improving social capital and political participation. They also estimated that "the Internet will be more strongly associated with positive life outcomes than will forms of Internet use that represent pure consumption activities" (DiMaggio, Hargittai 2001: 13). For positive outcomes of the ICT, education is vital. In all indexes, there are several indicators associated with education. For example, the mean year of schooling, secondary and tertiary gross enrolment ratio is in IDI; ICT graduates, ICT specialists, and female ICT specialists are involved in DESI, and top-performing 15- to 16-year-old students in science, mathematics, and reading are in the Going Digital Toolkit.

In addition to education, many indicators in the three indexes are intensely connected to demographic and socio-economic factors. Here are some indicators: disparity in broadband uptake between urban and rural households, the disparity in Internet use between men and women, and ICT investment as a percentage of GDP. All indicators are listed in Appendix B.

A new digital divide index

In this study, the digital divide is considered in four phases. Even if it seems similar to the existing literature, there are some unique considerations. The first step represents material access and skills together because conscious usage of them is possible with proper strategic, informational, and instrumental digital skills (van Dijk 2005). The second step represents the usage in terms of variety and regularity (DiMaggio, Hargittai 2001; Warschauer 2003; van Deursen, van Dijk 2018). The third phase represents the outcome of Internet usage (van Deursen, Helsper 2015); the consequences can create benefits for individual users or an innovation driver for communities or countries. In Türkiye's case, using technology as a booster of innovation is crucial to overcome the digital divide in terms of Singer's (1970) theory of technological dualism. Thus, here in this study, innovation is considered the primary effect.

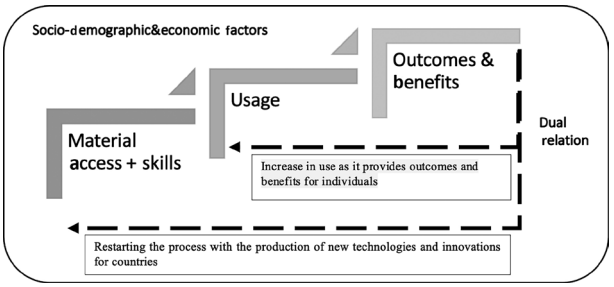

Fig. 1. Conceptual framework of digital divide levels in Türkiye.
Source: authors.

As a final comment, to have digital inclusions, all three phases should be equal for all individuals in various socio-demographic and socio-economic conditions (ITU 2017; EU 2018; OECD 2021a,b,c). Thus, the fourth phase represents socio-demographic and socio-economic divides.

Data and methodology

In the previous section, three recent and international indexes, IDI (ITU 2017), DESI (EU 2021), and Going Digital Toolkit (OECD 2021a,b,c), were analysed. According to the proposed conceptual framework, the second step is identifying digital inequality indicators that can be used in Türkiye's case. After identifying appropriate indicators, the data-gathering process starts via various data sources. While TurkStat is the leading data provider, various other public and private authorities, such as the Information Technologies and Communications Authority, Ministry of Industry and Technology, and TurkPatent, were used as statistical data resources for the study. All indicators with data sources and units are listed in Appendix C. Thanks to principal component analysis (PCA), a new index for Türkiye will be constructed. As a final step, QGIS does the spatial analysis of digital inequalities at the regional scale (NUTS1 – 12 sub-regions) and provincial scale (NUTS3 – 81 provinces).

Exploring indicators for Türkiye

All indicators are divided into four categories explained in the conceptual framework. There are 19 indicators associated with the first-level digital divide, 30 indicators are connected to the second-level digital divide, and 17 hands are mainly about the third-level digital divide. Finally, 21

of them are primarily corresponding to other divides. All indicators are listed in Appendix B. After the categorisation, the next step is to evaluate them in the case of Türkiye. To do so, three questions help with the identification. They are as follows:

1. Does the indicator differ within the regions in Türkiye?
2. Is the indicator associated with digital inequalities in Türkiye?
3. Is there precise or equivalent statistical data for the indicators?

First, indicators that are no different within the country are eliminated, such as the broadband price index, OECD digital government index, health data sharing intensity, OECD digital services trade restrictiveness index, and OECD foreign direct investment regulatory restrictiveness index. Then, indicators that are irrelevant to digital inequalities in Türkiye are removed. For example, 5G mobile technology is not available in Türkiye, yet instead, the availability of 3G/4G mobile technology indicates digital inequality. Another decent example is a fixed telephone subscription, which is decreasing with mobile phone expansion, thus unrelating to digital inequality.

Some indicators are substituted comparable statistical data, such as techno parks, R&D, and design centres are represented as digital-intensive sectors. Since 2001, Türkiye has supported them with specific laws: Law No. 5746 on Technology Development Zones (TDZ) and Law No. 5746 on Supporting Research, Development, and Design Activities. Both laws aim to support and encourage the production of technological knowledge to make the country's economy internationally competitive (Technology Development Zones 2001; Supporting Research, Development, and Design Activities 2008). Thus, this study accepts techno parks, R&D, and design centres as digital-intensive sectors. The number of businesses making e-commerce, ICT goods, and services as a share of international trade is also used as third-level digital divide indicators. Additionally, demographic and socio-economic factors play a vital role in Türkiye because low purchasing power creates an economic barrier to digital technologies (Ozcan Alp, Baycan 2024). ITU (2017) states that computer ownership in Türkiye is 20% lower than the European average. Additionally, Türkiye's human capital score is nearly half of the average score of the EU member states (EU 2021). Another interesting aspect is gender inequality; the gap in Internet use between men and women in the western part is smaller compared to the eastern part of Türkiye being 6% and 22%, respectively (TurkStat 2021). Demographic and socio-economic factors include disparity in Internet use between men and women, age dependency, mean year of schooling, secondary gross enrolment ratio, percentage of tertiary graduates, poverty ratio, urban and rural households, business R&D expenditure, and GDP.

As a final step, repeated indicators are gathered, such as the percentage of households with Internet access, the share of households with fixed broadband access, and the rate of households with mobile broadband access. Similarly, indicators related to Internet speed are simplified at the length of fibre optic cable since there is no other suitable statistic for Internet speed in Türkiye.

Unluckily, many indicators could not be used because of a lack of precise or equivalent statistical data. No region- or city-scale data are available since many are measured countrywide, such as individuals' basic digital and software skills, enterprises providing ICT training, and electronic information sharing. Furthermore, the study has limited the need for regional statistics such as e-government and e-health usage. Even if the ratio of e-government users is increasing in Türkiye (58.9%), it is still not equal among all regions (TurkStat 2021). Another significant limitation of the study was that there were no data on digital literacy and skills at a regional scale, which is the most problematic issue in Türkiye. In particular, digital skills are missing in Level 1. According to DESI (2020), Türkiye's human capital score (23.0) was almost half the EU member states' average (41.8). The final list of indicators can be seen in Table 3. All indicators with data sources and units are listed in Appendix C (Table 3).

Principal component analysis is used to determine the final indicators. PCA helps to have a relatively simple index by dropping the number of variables. It has been performed for all levels using the Statistical Package for the Social Sciences (SPSS). Before PCA, Pearson correlation is applied to all data, and indicators with a high correlation are eliminated by checking the correlation matrix score ($r > 0.80$). Six indicators have

been removed as the high correlation score are the percentage of households with fixed broadband access, the share of the population covered by at least a 4G mobile network, mean year of schooling, percentage of tertiary graduates, and GDP. Then, PCA is applied to the remaining indicators. Three main steps are as follows:

1. The significance of KMO and Bartlett's test was checked (KMO > 0.6 and Bartlett sig < 0.05).

Table 3. Digital divide indicators for Türkiye.

Level 1	Level 2	Level 3	Additionals
Percentage of households with Internet access	Percentage of computer usage	ICT firms in the business population	Disparity in Internet use between men and women
Percentage of households with fixed broadband access	Mobile cellular telephone subscriptions per 100 inhabitants	Techno parks, R&D, and design centres	Percentage of age dependency
Percentage of households with mobile broadband access	Percentage of individuals using the Internet	Total number of businesses making e-commerce	Mean year of schooling
Length of fibre	Fixed broadband subscriptions per 100 inhabitants	ICT goods and services as a share of international trade	Secondary gross enrolment ratio
Share of the population covered by at least a 4G mobile network	Active mobile broadband subscriptions per 100 inhabitants		Percentage of tertiary graduates
			Poverty ratio
			Urban and rural households
			Business R&D expenditure
			GDP

Source: authors.
ICT – information and communication technology.

Table 4. Results of PCA.

	Eigenvalues	Share of variance explained (%)	Cumulative share of variance explained (%)
First-level indicators – access and skills. Bartlett's test: Approx. chi-square (14.126) (p = 0.03, p < 0.05)			
Component 1	2.266	75.538	75.538
Component 2	0.567	18.908	94.447
Component 3	0.167	5.553	100.000
Second-level indicators – usage. Bartlett's test: Approx. chi-square (92.191) (p = 0.01, p < 0.05)			
Component 1	4.416	88.316	88.316
Component 2	0.428	8.561	96.877
Component 3	0.123	2.451	99.328
Component 4	0.031	0.617	99.946
Component 5	0.003	0.054	100.000
Third-level indicators – outcomes. Bartlett's test: Approx. chi-square (25.286) (p = 0.01, p < 0.05)			
Component 1	2.580	86.008	86.008
Component 2	0.349	11.649	97.657
Component 3	0.070	2.343	100.000
Additional divides – demographic and socio-economic factors. Bartlett's test: Approx. chi-square (40.276) (p = 0.01, p < 0.05)			
Component 1	3.614	72.281	72.281
Component 2	0.855	17.098	89.380
Component 3	0.346	6.922	96.301
Component 4	0.112	2.231	98.533
Component 5	0.073	1.467	100.000

Source: authors.
PCA – principal component analysis.

2. Communalities were examined in how each factor affected the total factor, and weak values were eliminated (extraction <500).
3. According to the component matrix TBA analysis, those with a low coefficient of explanation (Component Loadings <600) were excluded.

ICT goods and services as a share of international trade and poverty ratio are eliminated because of PCA. After that, for each level, PCA was applied with the final indicators for each level. The results derived from the PCA are shown in Table 4.

Thanks to PCA, final indicators are determined. Then, to have a precise index, the weights are computed with the help of the IDI methodology. Finally, the following three steps are performed:

1. The component loadings were squared and divided by the share of variance explained by the component.
2. The results were multiplied by the variance ratio explained by the component and total variance.
3. The derived weights were rescaled to sum up to 100 (to increase comparability) (ITU 2009: 81).

The contribution of all four levels to the new index has been determined to be equal. As a final step, the ideal value is calculated by adding two standard deviations to the mean value of the indicator (ITU 2009). After various stages, the last index can be seen in Table 5.

Results and discussion

The new index is applied at regional (NUTS1 – 12 sub-regions) and city scales (NUTS3 – 81 provinces). The results indicate a digital divide among Türkiye regions. While regions generally converge in terms of access and use of technology (Levels 1 and 2), it is seen that the tangible benefits obtained from technology (Level 3) differ from each other in Türkiye. Levels 1 and 2 score between 0.25–0.18 and 0.49–0.28, respectively. However, the score range varies for Level 3, between 1.98 and 0.01. At the same time, it is observed that the socio-economic and demographic factors (Level 4) that are effectual in outcomes differ between regions. The score range varies for Level 4, between 0.15 and 0.07. Since Level 3 represents the outcome of Internet usage (van Deursen, Helsper 2015), to be specific,

Table 5. A digital divide index for Türkiye with final indicators.

	Ideal value	Indicator weights (%)	Level weights (%)
First-level indicators – access and skills			
Percentage of households with broadband access	100	0.30	0.25
Percentage of households with mobile broadband access	100	0.40	
Length of fibre	55,000	0.30	
Second-level indicators – usage			
Percentage of computer usage	80	0.30	0.25
Percentage of individuals using the Internet (regular)	100	0.30	
Fixed broadband subscriptions per 100 inhabitants	30	0.40	
Active mobile broadband subscriptions per 100 inhabitants	100	0.50	
Mobile cellular telephone subscriptions per 100 inhabitants	130	0.50	
The third-level indicators – outcomes			
ICT firms in the business population	6,000	0.30	0.25
Techno parks, R&D, and design centres	2,500	0.40	
Total number of businesses making e-commerce	1,200	0.30	
Additional divides – demographic and socio-economic factors			
Disparity in Internet use between men and women	20	0.20	0.25
Percentage of age dependency	70	0.20	
Secondary gross enrolment ratio	100	0.20	
Urban/rural households	100	0.20	
R&D expenditure as a percentage of GDP	2	0.20	

Source: authors.
ICT – information and communication technology.

Table 6. Regional digital divide results.

		I	II	III	IV
TR1	Istanbul	0.25	0.49	1.98	0.15
TR2	West Marmara	0.18	0.36	0.06	0.12
TR3	Aegean	0.24	0.37	0.81	0.13
TR4	Eastern Marmara	0.21	0.38	0.23	0.16
TR5	Western Anatolia	0.21	0.41	0.40	0.19
TR6	Mediterranean	0.23	0.35	0.16	0.12
TR7	Central Anatolia	0.20	0.34	0.06	0.11
TR8	Western Black Sea	0.18	0.34	0.05	0.11
TR9	Eastern Black Sea	0.18	0.34	0.03	0.10
TRA	Northeast Anatolia	0.18	0.28	0.01	0.07
TRB	Middle East Anatolia	0.19	0.28	0.02	0.09
TRC	Southeastern Anatolia	0.20	0.28	0.06	0.07

Source: authors.

Table 7. Provincial digital divide results with top and bottom scores.

		I	II	III	IV
TR100	Istanbul	0.25	0.35	1.98	0.15
TR310	Izmir	0.18	0.30	0.70	0.14
TR510	Ankara	0.19	0.32	0.35	0.21
TR411	Bursa	0.18	0.29	0.10	0.15
TR421	Kocaeli	0.17	0.29	0.06	0.17
TR611	Antalya	0.18	0.29	0.08	0.13
TRB23	Bitlis	0.16	0.19	0.00	0.06
TRA23	Iğdır	0.15	0.20	0.00	0.05
TRA22	Kars	0.15	0.19	0.00	0.05
TRC33	Şırnak	0.17	0.19	0.00	0.05
TRA21	Ağrı	0.15	0.18	0.00	0.04
TRB22	Muş	0.16	0.18	0.00	0.04

Source: authors.

economic outcomes are considered the primary outcome in this study; the disparities are conspicuous. It can be related to socio-economic and demographic factors and unequal ability to use ICT (Warschauer 2011) to have offline outcomes (van Deursen, Helsper 2015). Supportively, Türkiye's human capital score is lower than most EU members (EU 2021). Another critical factor is R&D expenditure as a percentage of GDP and the disparity in Internet use between men and women. That indicators show relatively unequal distribution between the regions.

Furthermore, two distinctive indicators in Level 3 are ICT companies in the business population and techno parks, R&D, and design centres for the regions in Türkiye. Therefore, these two indicators need to be targeted to boost the outcomes of ICTs and overcome technological dualism.

The results indicate that fostering the ability to use technology, supporting gender equality, encouraging R&D expenditures, and supporting initiatives, especially ICT initiatives, will assist in reducing digital inequalities in Türkiye. Tables 6 and 7 represent the new index scores on regional and city scales.

Regional scale (NUTS1 – 12 sub-regions)

Digital development differences between regions within Türkiye are seen in Figure 2. TR1

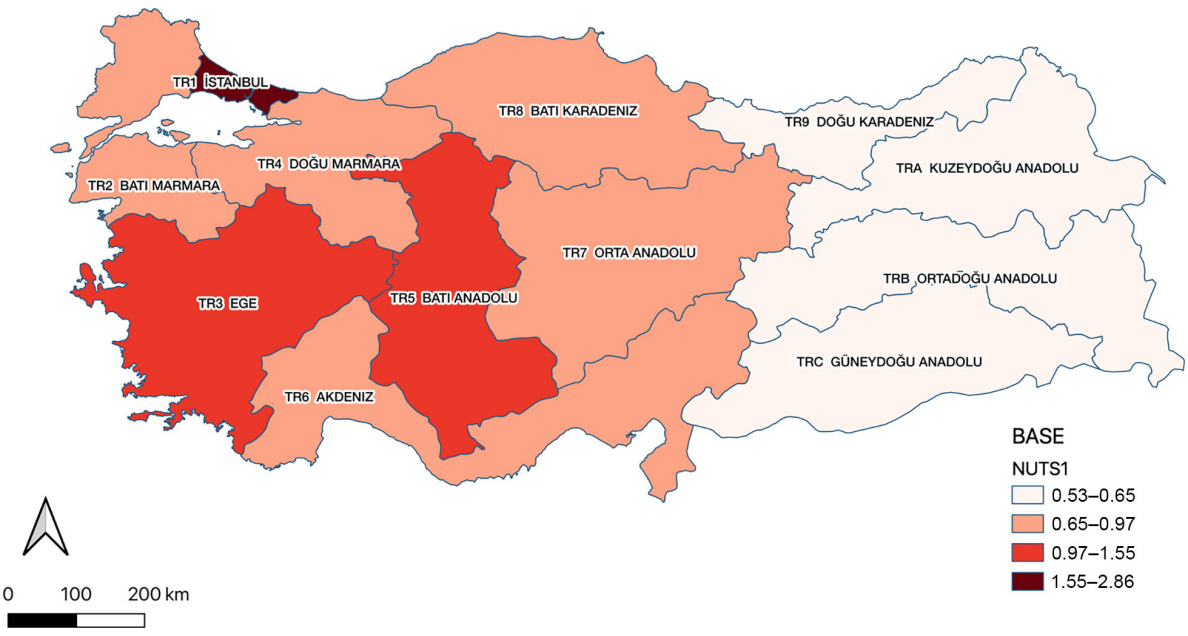

Fig. 2. Digital divide in the regions of Türkiye.
Source: authors.

Istanbul has the highest digitisation value (2.86), followed by the TR5 Western Anatolia region, which has almost half the highest value (1.55). The score ranges from 1.55 to 0.53 within 12 sub-regions, excluding TR1 Istanbul. Digital progress is more significant in the western part of Türkiye than in the eastern region. However, TR2 Western Marmara has lower values, similar to the eastern part of Türkiye. Each region has its strengths and weaknesses related to the overall score. For example, TR5 West Anatolia region stands out with its excessive R&D expenditures, total number of techno parks, R&D, and design centres and high e-commerce usage; TR4 East Marmara region has the second highest R&D expenditures. There are some unpredicted results, as well. Even if TR5 West Anatolia and TR4 East Marmara have higher R&D expenditures, TR3 Aegean region has left them behind with the abundance of ICT initiatives and high e-commerce usage.

The most critical problems in the eastern regions (TRA Northeast Anatolia, TRB Middle East Anatolia, and TRC Southeast Anatolia) that have the lowest values are the difference in Internet use between men and women, the low rate of computer use, and the low R&D expenditures.

City scale (NUTS3 – 81 provinces)

TR100 Istanbul significantly differs from all provinces at the city scale, similar to the regional scale. However, the inequalities between provinces are more pronounced than in regions. Some cities stand out with specific indicators, such as TR310 İzmir excessive enterprises, TR510 Ankara with high R&D expenditures, and the number of techno parks, R&D, and design centres. On the other hand, while the number of enterprises is high in TR421 Kocaeli, the rate of ICT enterprises is relatively low. That caused a low overall index value, and TR411 Bursa surpassed TR421 Kocaeli's ICT initiatives.

Conclusion

This article proposes a new digital development monitoring index to understand and observe the digital development differences in Türkiye. With the help of the current literature, a comprehensive monitoring index is presented. The monitoring tool consists of three different levels of digital divide: Level 1 represents material access and skills (van Dijk 2005), Level 2 represents usage in terms of variety and regularity

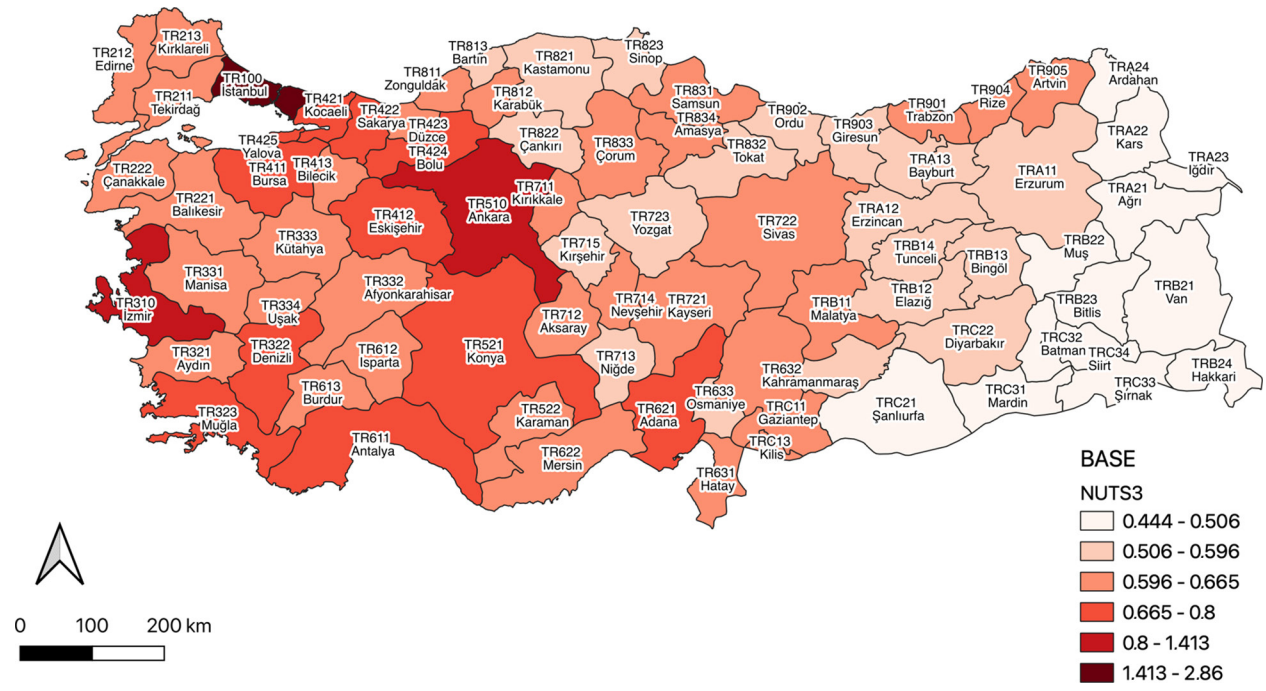

Fig. 3. Digital divide in the cities of Türkiye.
Source: authors.

(DiMaggio, Hargittai 2001; Warschauer 2003; van Deursen, van Dijk 2018), and Level 3 represents the outcome of Internet usage (van Deursen, Helsper 2015) and economic outcomes; specifically, innovation is considered the primary outcome (Shakina et al. 2021). As a further divide, all individuals in various socio-demographic and socio-economic conditions (ITU 2017; EU 2018; OECD 2021a,b,c) should be considered equal for digital inclusion.

The indicators encompassing all aspects of the digital divide are analysed for Türkiye. The maps indicate the digital divide at regional level (NUTS1 – 12 Sub-Regions) and city level (NUTS3 – 81 provinces); however, disparities are more significant at the city scale. While regions in Türkiye generally converge in terms of access and use of technology (the first and second-level digital divide), the tangible benefits of technology (the third-level digital divide) are divergent. The primary findings of the study indicate the reasons, which are uneven digital skills, socio-economic and demographic divides, and R&D expenditure as a percentage of GDP. All of them gain imbalanced scores between the regions. To enhance digital inclusion, Türkiye needs to focus on fostering the ability to use technology, supporting gender equality, encouraging R&D expenditures, and supporting initiatives, especially ICT initiatives.

This study has developed a comprehensive index containing all digital divide aspects. In addition, the results demonstrate how digital inequalities exist in regions within the same country. Similar to the previous studies, the findings show that there are many determinants of outcomes of technology usage. This study's determinants are uneven digital skills, socio-economic and demographic factors, and R&D expenditure. However, the study has some limitations owing to a lack of precise or equivalent statistical data at a regional scale, such as individuals' basic digital and software skills, ICT usage in enterprises, e-government usage, and digital literacy. Despite these study limitations, digital development differences at the regional scale have been revealed. More than that, the regional strengths and weaknesses have been exposed. Future studies can be focused on the physical effects of digitalisation in cities.

Authors' contribution

This study is based on Gulfiye Ozcan Alp's doctoral dissertation entitled, 'A Search for A Smart Sustainable City: Overcoming Digital Divide' supervised by Prof. Dr. Tuzin Baycan and supported by the 100/2000 CoHE Doctoral program. Earlier versions of this study were presented at the 21st National Regional Science and Planning Congress, Türkiye, Gazi University, Ankara, 26–28 May, 2022.

Disclosure Statement

No potential conflict of interest was reported by the authors.

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Appendix A. Indicators of ICT Development Index (IDI) (ITU 2017), the Digital Economy and Society Index (DESI) (EU 2021), and Going Digital Toolkit (OECD 2021).

ICT Development Index (IDI) (ITU 2017).

Dimension	Indicator
ICT Access 40%	1. Fixed telephone subscriptions per 100 inhabitants
	2. Mobile cellular telephone subscriptions per 100 inhabitants
	3. International Internet bandwidth (bit/s) per Internet user
	4. Percentage of households with a computer
	5. Percentage of households with Internet access
ICT Use 40%	6. Percentage of individuals using the Internet
	7. Fixed broadband subscriptions per 100 inhabitants
	8. Active mobile broadband subscriptions per 100 inhabitants
ICT Skills 20%	9. Mean year of schooling
	10. Secondary gross enrolment ratio
	11. Tertiary gross enrolment ratio

The Digital Economy and Society Index (DESI) (EU 2021).

Dimension	Sub-dimension	Indicator
1 Human capital 25%	1a Internet user skills	1a1 At least basic digital skills
		1a2 Above basic digital skills
		1a3 At least basic software skills
	1b Advanced skills and development	1b1 ICT specialists
		1b2 Female ICT specialists
		1b3 Enterprises providing ICT training
		1b4 ICT graduates
2 Connectivity 25%	2a Fixed broadband take-up	2a1 Overall fixed broadband take-up
		2a2 At least 100 Mbps fixed broadband take-up
		2a3 At least 1 Gbps take-up
	2b Fixed broadband coverage	2b1 Fast broadband (NGA) coverage
		2b2 Fixed Very High Capacity Network (VHCN) coverage
	2c Mobile broadband	2c1 4G coverage
		2c2 5G readiness
		2c3 5G coverage
		2c4 Mobile broadband take-up
	2d Broadband prices	2d1 Broadband price index
3 Integration of Digital Technology 25%	3a Digital intensity	3a1 SMEs with at least a basic level of digital intensity
	3b Digital technologies for businesses	3b1 Electronic information sharing
		3b2 Social media
		3b3 Big data
		3b4 Cloud
		3b5 AI
		3b6 ICT for environmental sustainability
		3b7 e-Invoices
	3c e-Commerce	3c1 SMEs selling online
		3c2 e-Commerce turnover
		3c3 Selling online cross-border
4 Digital Public Services 25%	4a e-Government	4a1 e-Government users
		4a2 Pre-filled forms
		4a3 Digital public services for citizens
		4a4 Digital public services for businesses
		4a5 Open data

Going Digital Toolkit (OECD 2021).

Dimension	Indicator
Access	1. Fixed broadband subscriptions per 100 inhabitants 2. M2M (machine-to-machine) SIM cards per 100 inhabitants 3. Mobile broadband subscriptions per 100 inhabitants 4. Share of households with broadband connections 5. Share of businesses with broadband contracted speed of 30 Mbps or more 6. Share of the population covered by at least a 4G mobile network 7. Disparity in broadband uptake between urban and rural households
Use	1. Internet users as a share of individuals 2. Share of individuals using the Internet to interact with public authorities 3. Share of Internet users who have purchased online 4. Share of small businesses making e-commerce sales 5. Share of businesses with a web presence 6. Share of businesses purchasing cloud services 7. Average monthly mobile data usage per mobile broadband subscription, GB 8. Share of adults proficient at problem-solving in technology-rich environments
Innovation	1. ICT investment as a percentage of GDP 2. Business R&D expenditure in information industries as a percentage of GDP 3. Venture capital investment in the ICT sector as a percentage of GDP 4. Share of start-up companies (up to 2 years old) in the business population 5. Top 10% most-cited documents in computer science, as a percentage of the top 10% ranked documents 6. Patents in ICT-related technologies, as a percentage of total IP5 patent families
Jobs	1. ICT task-intensive jobs as a percentage of total employment 2. Digital-intensive sectors' share in total employment 3. Workers receiving employment-based training, as a percentage of total employment 4. New tertiary graduates in science, technology, engineering, and mathematics, as a percentage of new graduates 5. Public spending on active labour market policies, as a percentage of GDP
Society	1. Percentage of individuals aged 55–74 using the Internet 2. Percentage of individuals who live in households with income in the lowest quartile who use the Internet 3. Women as a share of all 16- to 24-year-olds who can program 4. Disparity in Internet use between men and women 5. Percentage of individuals who use digital equipment at work that telework from home once a week or more 6. Top-performing 15- to 16-year-old students in science, mathematics and reading 7. OECD Digital Government Index 8. e-Waste generated, kilogrammes per inhabitant
Trust	1. Percentage of Internet users experiencing abuse of personal information or privacy violations 2. Percentage of individuals not buying online because of payment security concerns 3. Percentage of individuals not buying online because of concerns about returning products 4. Percentage of businesses in which ICT security and data protection tasks are mainly performed by own employees 5. Health data sharing intensity
Market Openness	1. Share of businesses making e-commerce sales that sell across borders 2. Digitally deliverable services as a share of commercial services trade 3. ICT goods and services as a share of international trade 4. Digital-intensive services value added embodied in manufacturing exports, as a percentage of manufacturing export value 5. OECD Digital Services Trade Restrictiveness Index 6. OECD Foreign Direct Investment Regulatory Restrictiveness Index

Appendix B. Indicators related to three level of digital divide in ICT Development Index (IDI) (ITU 2017), the Digital Economy and Society Index (DESI) (EU 2021), and Going Digital Toolkit (OECD 2021).

First-Level Digital Divide – 19 indicators

Index	Indicator
IDI	3. International Internet bandwidth (bit/s) per Internet user
	4. Percentage of households with a computer
	5. Percentage of households with Internet access
DESI	1a1 At least basic digital skills
	1a2 Above basic digital skills
	1a3 At least basic software skills
	2a1 Overall fixed broadband take-up
	2a2 At least 100 Mbps fixed broadband take-up
	2a3 At least 1 Gbps take-up
	2b1 Fast broadband (NGA) coverage
	2b2 Fixed Very High Capacity Network (VHCN) coverage
	2c1 4G coverage
	2c2 5G readiness
	2c3 5G coverage
	2c4 Mobile broadband take-up
Digital Toolkit	M2M (Machine-to-machine) SIM cards per 100 inhabitants
	Share of households with broadband connections
	Share of businesses with broadband contracted speed of 30 Mbps or more
	Share of the population covered by at least a 4G mobile network

Second-Level Digital Divide – 30 indicators

Index	Indicator
IDI	1. Fixed telephone subscriptions per 100 inhabitants
	2. Mobile cellular telephone subscriptions per 100 inhabitants
	6. Percentage of individuals using the Internet
	7. Fixed broadband subscriptions per 100 inhabitants
	8. Active mobile broadband subscriptions per 100 inhabitants
DESI	1b3 Enterprises providing ICT training
	3a1 SMEs with at least a basic level of digital intensity
	3b1 Electronic information sharing
	3b2 Social media
	3b3 Big data
	3b4 Cloud
	3b5 AI
	3b7 e-Invoices
	4a1 e-Government users
	4a2 Pre-filled forms
	4a3 Digital public services for citizens
	4a4 Digital public services for businesses
	4a5 Open data

Index	Indicator
Digital Toolkit	Fixed broadband subscriptions per 100 inhabitants
	Mobile broadband subscriptions per 100 inhabitants
	Internet users as a share of individuals
	Share of individuals using the Internet to interact with public authorities
	Share of Internet users who have purchased online
	Share of businesses with a web presence
	Share of businesses purchasing cloud services
	Percentage of individuals who use digital equipment at work that telework from home once a week or more
	OECD Digital Government Index
	Health data sharing intensity
	OECD Digital Services Trade Restrictiveness Index
	OECD Foreign Direct Investment Regulatory Restrictiveness Index

Third-Level Digital Divide – 17 indicators

Index	Indicator
IDI	None
DESI	3b6 ICT for environmental sustainability
	3c1 SMEs selling online
	3c2 e-Commerce turnover
	3c3 Selling online cross-border
Digital Toolkit	Share of small businesses making ecommerce sales
	Percentage of Internet users experiencing abuse of personal information or privacy violations
	Percentage of individuals not buying online because of payment security concerns
	Percentage of individuals not buying online because of concerns about returning products
	Share of businesses making e-commerce sales that sell across borders
	Digitally deliverable services as a share of commercial services trade
	ICT goods and services as a share of international trade
	Share of start-up firms (up to 2 years old) in the business population
	Top 10% most-cited documents in computer science, as a percentage of the top 10% ranked documents
	Patents in ICT-related technologies, as a percentage of total IP5 patent families
	ICT task-intensive jobs as a percentage of total employment
	Digital-intensive sectors' share in total employment
	e-Waste generated, kilogrammes per inhabitant

Additional Divides – 21 indicators

Index	Indicator
IDI	9. Mean year of schooling
	10. Secondary gross enrolment ratio
	11. Tertiary gross enrolment ratio
DESI	1b1 ICT specialists
	1b2 Female ICT specialists
	1b4 ICT graduates
	2d1 Broadband price index
	Disparity in broadband uptake between urban and rural households
Digital Toolkit	Percentage of individuals aged 55–74 using the Internet
	Percentage of individuals who live in households with income in lowest quartile who use the Internet
	Women as a share of all 16- to 24-year-olds who can program
	Disparity in Internet use between men and women
	Top-performing 15- to 16-year-old students in science, mathematics and reading
	Workers receiving employment-based training, as a percentage of total employment
	New tertiary graduates in science, technology, engineering, and mathematics, as a percentage of new graduates

Index	Indicator
	ICT investment as a percentage of GDP
	Business R&D expenditure in information industries as a percentage of GDP
	Venture capital investment in the ICT sector as a percentage of GDP
	Percentage of businesses in which ICT security and data protection tasks are mainly performed by own employees
	Digital-intensive services value added embodied in manufacturing exports, as a percentage of manufacturing export value
	Public spending on active labour market policies, as a percentage of GDP

Appendix C. Indicators related to three levels of digital divide and data source.

	Source	Year	Scale	Units
First-level indicators – access and skills				
Percentage of households with broadband access	TurkStat	2021	TR1	% households
Percentage of households with fixed broadband access	TurkStat	2021	TR1	% households
Percentage of households with mobile broadband access	TurkStat	2021	TR1	% households
Length of fibre	BTK	2020	TR1 – TR3	Km
Ratio of 3G + 4.5G subscriptions	BTK	2020	TR1 – TR3	% inhabitants
Second-level indicators – usage				
Percentage of computer usage	TurkStat	2018	TR1	% inhabitants
Percentage of individuals using the Internet (regular)	TurkStat	2021	TR1	% inhabitants
Fixed broadband subscriptions per 100 inhabitants	BTK	2020	TR1 – TR3	% inhabitants
Active mobile broadband subscriptions per 100 inhabitants	BTK	2020	TR1 – TR3	% inhabitants
Mobile cellular telephone subscriptions per 100 inhabitants	BTK	2020	TR1 – TR3	% inhabitants
Third-level indicators – outcomes				
ICT companies in the business population	TurkStat	2020	TR1–TR3	Total ICT eneterprise number
Total number of businesses making e-commerce	ETBIS	2022	TR1–TR3	Total business number
ICT goods and services as a share of international trade	TurkStat	2020	TR1–TR3	($)
Additional divides – demographic and socio-economic factors				
Disparity in Internet use between men and women	TurkStat	2021	TR1	Women – man differences
Percentage of age dependency	TurkStat	2021	TR1–TR3	Ratio of independent population
Mean year of schooling	Ministry of Education	2019	TR1–TR3	Mean year
Secondary gross enrolment ratio	TurkStat	2020	TR1–TR3	Gross enrolment ratio
Percentage of tertiary graduates	TurkStat	2020	TR1–TR3	% total population
Poverty ratio	TurkStat	2020	TR1 – TR2	% total population
Urban and rural households	TurkStat	2021	TR1–TR3	% inhabitants live in cities
R&D expenditure as a percentage of GDP	TurkStat	2020	TR1 – TR2	(TL)
GDP	TurkStat	2020	TR1–TR3	(TL)